

# UNITED STATES PATENT AND TRADEMARK OFFICE CERTIFICATE OF CORRECTION

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PATENT NO. : 7,331,012  
APPLICATION NO. : 10/634,723  
ISSUE DATE : February 12, 2008  
INVENTOR(S) : Bane Vasic et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 6, lines 28–31, please delete:**

" 0\*(1111111111111111)+1\*(0000000011111111)+1\*(0000111100001111)+0\*(0011001100110011)+0\*(0000000000001111)+0\*(0000000000110011)+0\*(0000000001010101)=(0000111111110000). "

**and insert therefore:**

-- 0\*(1111111111111111)+1\*(0000000011111111)+1\*(0000111100001111)+0\*(0011001100110011)+0\*(0101010101010101)+0\*(0000000000001111)+0\*(0000000000110011)+0\*(0000000001010101)=(0000111111110000). --

**At col. 6, lines 28–31, please delete:**

"FIG. 3 illustrates a communication circuit 10 according to the present invention. The communication circuit 10 includes an RM-encoder 12, a partial-response channel 14, and a Reed-Muller partial response decoder 16 (RM-PR 16). For simplicity, a transmission of a single codeword  $m$  is shown, though the same principle of operation holds for every message word transmitted. As shown, codeword  $m$  is input into the RM encoder 12, which generates an RM-encoded codeword  $x$ . RM-encoded codeword  $x$  is transmitted over the Partial-Response (PR) channel 14, which tends to introduce noise to the codeword  $x$  such that the received codeword  $y$  contains unknown errors. As shown, the received codeword  $y$  is input into the RM-PR decoder 16, which produces an output decoded codeword."

**and insert therefore:**

-- FIG. 3 illustrates a communication circuit 10 according to the present invention. The communication circuit 10 includes an RM-encoder 12, a partial-response channel 14, and a Reed-Muller partial response decoder 16 (RM-PR 16). For simplicity, a transmission of a single codeword  $m$  is shown, though the same principle of operation holds for every message word transmitted. As shown, codeword  $m$  is input into the RM encoder 12, which generates an RM-encoded codeword  $x$ . RM-encoded codeword  $x$  is transmitted over the Partial-Response (PR) channel 14, which tends to introduce noise to the codeword  $x$  such that the received codeword  $y$  contains unknown errors. As shown, the received codeword  $y$  is input into the RM-PR decoder 16, which produces an output decoded codeword.

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**At col. 9, lines 15–16, please delete:**

"The interleaver 18 orders re-orders the RM-encoded codeword  $x$  prior to passing the codeword  $x$  to the partial-response channel 14."

**and insert therefore:**

-- The interleaver 18 randomly re-orders the RM-encoded codeword  $x$  prior to passing the codeword  $x$  to the partial-response channel 14. --

**At col. 10, lines 42–46, please delete:**

"The BCJR or SOVA device 20A has no initial reliability vector  $\lambda(\hat{n})$  associated with the received code word  $y$ , so the second input of the BCJR or SOVA device 20A is a reliability vector  $\lambda(\hat{x})$  of value zero, providing no indication of reliability."

**and insert therefore:**

-- The BCJR or SOVA device 20A has no initial reliability vector  $\lambda(\hat{x})$  associated with the received code word  $y$ , so the second input of the BCJR or SOVA device 20A is a reliability vector  $\lambda(\hat{x})$  of value zero, providing no indication of reliability. --

**At col. 11, lines 34–35, please delete:**

"corresponding to  $G_s$  (with) message word bits  $x_s^{(j)}$  having index  $s$  such that "

**and insert therefore:**

-- corresponding to  $G_s$  (with message word bits  $x_s^{(j)}$  having index  $s$  such that --

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**At col. 11, lines 50-57, please delete:**

" In each array  $P_s$ , each column shows the locations of the code bits to be added together to give an estimation of the message bit  $x_s$ . This addition is modulo-2 addition. In the hard-coding version, the message bit is determined by a majority vote among all  $2^{m-1}$  estimations, (as described above), and the received code vector is updated according to the relation  $y \leftarrow y \otimes x^{(j)} G_j$ , and then passed to the next decoding step (step  $j \times 1$ ). "

**and insert therefore:**

-- In each array  $P_s$ , each column shows the locations of the code bits to be added together to give an estimation of the message bit  $x_s^{(j)}$ . This addition is modulo-2 addition. In the hard-coding version, the message bit is determined by a majority vote among all  $2^{m-1}$  estimations, (as described above), and the received code vector is updated according to the relation  $y \leftarrow y + x^{(j)} G_j$ , and then passed to the next decoding step (step  $j+1$ ). --

**At col. 11, lines 62-64, please delete:**

$$" LLR(b_s) = \log \left( \frac{Probability(b_s = +1|y)}{Probability(b_s = -1|y)} \right) "$$

**and insert therefore:**

$$-- LLR(b_s) = \log \left( \frac{Probability(b_s = +1/y)}{Probability(b_s = -1/y)} \right) --$$

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 12, lines 5-32, please delete:**

$$\mu(\hat{m}_s^{i,j}) = -S_s^{i,j} \cdot \log \left\{ -\tanh \left( \frac{A_s^{i,j}}{2} \right) \right\} \quad (1)$$

$$S_s^{i,j} = \prod_i \text{sign}\{u(\hat{x}_i^{i,j,s})\} \quad (2)$$

where  $\mu(\hat{x}_i^{i,j,k})$  is the LLR of the expression for the s-th message bit from the i-th equation in the j-th level, and where

$$A_s^{i,j} = \sum_i \log \left| \tanh \left( \frac{\mu(\hat{x}_i^{i,j,s})}{2} \right) \right| \quad (3)$$

and "

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 12, lines 5-32, please insert therefore:**

$$-- \quad \mu(\hat{m}_s^{i,j}) = -S_s^{i,j} \cdot \log \left\{ -\tanh \left( \frac{A_s^{i,j}}{2} \right) \right\} \quad (1)$$

where  $\mu(\hat{x}_i^{i,j,s})$  is the LLR of the expression for the s-th message bit from the i-th equation in the j-th level, and where

$$S_s^{i,j} = \prod_l \text{sign}\{\mu(\hat{x}_i^{i,j,s})\} \quad (2)$$

and

$$A_s^{i,j} = \sum_l \log \left| \tanh \left( \frac{\mu(\hat{x}_i^{i,j,s})}{2} \right) \right|. \quad (3) --$$

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

**At col. 12, lines 56-63, please delete:**

" In the hard decoding version (Reed algorithm), a message bit is determined by a majority vote, and the received code vector is updated using the expression  $y \leftarrow y - x^{(j)} G_j$  given above, and then passed to the next decoding step. In the soft decoding version, prior to advancing to the next row of the decoder 16, the updated message bit likelihoods must be converted to the code bit likelihoods. This conversion is performed based on the submatrix  $G_j$ . "

**and insert therefore:**

-- In the hard decoding version (Reed algorithm), a message bit is determined by a majority vote, and the received code vector is updated using the expression  $y \leftarrow y + x^{(j)} G_j$  given above, and then passed to the next decoding step. In the soft decoding version, prior to advancing to the next row of the decoder 16, the updated message bit likelihoods must be converted to the code bit likelihoods. This conversion is performed based on the submatrix  $G_j$ . --

**At col. 13, lines 26-27, please delete:**

"Suppose that the nonzero positions of the l-th column of  $G_j$  are given by the set  $\{l_1 \dots l_i\}$  where "

**and insert therefore:**

-- Suppose that the nonzero positions of the l-th column of  $G_j$  are given by the set  $\{l_1 \dots l_i\}$  where --

**At col. 13, lines 63-65, please delete:** "  $\lambda(\hat{x}_l) = \left[ \prod_j \text{sign}\{u(\hat{m}_j)\} \right] \cdot \min\{|\mu(m_j)|\}$  "

**and insert therefore:** --  $\lambda(\hat{x}_l) = \left[ \prod_j \text{sign}\{\mu(\hat{m}_j)\} \right] \cdot \min\{|\mu(m_j)|\}$  --

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It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

$m_{10} = c_0 + c_1 + c_{2+c3}$

**At col. 14, lines 46–56, please delete: "**

$m_{10} = c_4 + c_5 + c_{6+c7}$  "

$m_{10} = c_8 + c_9 + c_{10+c11}$

$m_{10} = c_{12} + c_{13} + c_{14+c15}$

$m_{10} = c_0 + c_1 + c_2 + c_3$

$m_{10} = c_4 + c_5 + c_6 + c_7$

**and insert therefore: --**

$m_{10} = c_8 + c_9 + c_{10} + c_{11}$

$m_{10} = c_{12} + c_{13} + c_{14} + c_{15}$

**At col. 14, lines 63–66, please delete: "**  $P_{10} = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$  "

**and insert therefore: --**  $P_{10} = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$  --

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At col. 15, lines 10–15, please delete: " $P_1 = \begin{bmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 \end{bmatrix}$ "

and insert therefore: -- " $P_1 = \begin{bmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 8 & 9 & 10 & 11 & 12 & 13 & 14 & 15 \end{bmatrix}$ "  
 $P_0 = [0 \ 1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8 \ 9 \ 10 \ 11 \ 12 \ 13 \ 14 \ 15] --$

At col. 15, lines 20–30, please delete: " $P_3 = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 12 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$ "

and insert therefore: -- " $P_5 = \begin{bmatrix} 0 & 4 & 8 & 12 \\ 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \end{bmatrix}$ " --

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